Hydrogen Sulfide

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Fact Sheet

Environmental Health Programs
Office of Environmental Health Assessments

Hydrogen sulfide (H_2S) is a colorless, flammable gas, heavier than air, which at low concentrations smells like rotten eggs. Sensitive individuals can detect H_2S at concentrations as low as 3 ppb (parts per billion), but most can smell this characteristic odor between 20 and 30,000 ppb. Above this concentration it has a sweetish odor, while at higher concentrations still, it numbs the sense of smell. Due to this effect, odor is not a warning of the presence of the gas at high concentrations.

Environmental Sources

H_2S is produced in nature primarily through the decomposition of dead plant and animal matter by anaerobic sulfur bacteria. H_2S is also found in varying amounts in unrefined natural gas and petroleum, in sulfur deposits, volcanic gases and sulfur springs. It can also be a component of sewer gas.

Because it is heavier than air, it can accumulate in low-lying areas and in enclosed spaces. H_2S can be produced through industrial digestion of biological wastes, if the process is allowed to go anaerobic (lacking enough oxygen to allow oxygen-requiring bacteria to carry out their work). Thus, wastewater treatment, digestion of agricultural or pulp waste, composting of plant material, and accumulation of seaweed or other biological waste or debris can release H_2S if care is not taken to provide enough oxygen to these processes. The gas can also be formed on fouled catalytic converters of vehicles, from the sulfur in fuel. H_2S can be found in natural waters, well water, and sulfur springs.

Uses

H_2S is used in preparation of other sulfur compounds and is a by-product of much industrial manufacturing, including pulp and paper processes, manufacture of rayon, steel making, tanning of hides and processing of fur, and oil and natural gas production and processing, among others.

Health Impacts

H_2S is an irritant of mucous membranes of the eyes and respiratory tract. Eye effects include irritation, tearing, and inflammation with distorted vision. Prolonged exposure to levels around 10,000 ppb can damage the cornea.

Respiratory effects can occur at these same levels, or lower, resulting in feelings of nose and throat irritation, cough, and signs of inflammation. Asthma can be exacerbated by exposure to H_2S at these low levels. Exposure to levels of H_2S between 50,000 to 250,000 ppb for more than several hours can result in pulmonary edema, decreasing the ability to breathe effectively, which can be life threatening.

Hydrogen sulfide directly affects the nervous system. It stimulates the nerves of the common chemical sense (the vagus and trigeminal nerves). These have sensory endings around the eyes and face, inside the nose, mouth, nasal cavities and sinuses, and throat, and respond to pungency, rather than odor. These nerves, sensing irritant substances, cause responses such as increased mucus secretion, contraction of muscles of the throat, breath holding, and altered sensation, mood, and thinking ability.

Other nervous system effects such as headache, nausea, with or without vomiting, inability to concentrate on simple tasks, sleep disturbance, and loss of reasoning ability can occur at low levels (perhaps at less than 1,000 ppb). At concentrations between 20,000 and 50,000, there is a change of odor from rotten egg to sickeningly sweet, progressing to loss of all odor perception, as the sense of smell is paralyzed. These changes occur at differing concentrations for different people.

At concentrations of hundreds of thousands of parts per billion, sudden loss of consciousness can occur. Respiratory paralysis can also occur (together with loss of consciousness) at levels between 350,000 to 1,000,000 ppb and greater, after only a breath or two is inhaled. Unless victims are removed from exposure and revived, death will occur.

H_2S inhibits the enzyme that allows cells to use oxygen during energy metabolism. Although H_2S affects all cells in the body that it comes in contact with, it most affects the brain and the heart, because these tissues require large amounts of oxygen to function.

Air

Background air levels of H_2S in most parts of the U.S. not near specific sources are around 0.72 ppb in air. Air Pollution episodes have been recorded from 50 to 15,000 ppb, with very high accidental releases resulting in lethal levels between 500,000 and 1,000,000 ppb occurring rarely.

Water

H_2S is slightly soluble in water, and can be found in natural waters of geothermal springs, and some swamps. Even municipal drinking

water or well water can contain H_2S, although rarely in Washington. Sensitive individuals can respond with symptoms, including headache and nausea, to the dissolved gas or to that released into air from the water. H_2S is a weak acid in water and can corrode metal pipes.

Soil and Sediments

H_2S can accumulate in soil and sediments if there is a source (geothermal, natural gas, petroleum) or if biological anaerobic degradation is occurring, such as in swamps, or unaerated decaying plant and animal materials.

Food

Some foods contain high sulfur levels, particularly plants in the onion family, especially garlic. All biological material contains sulfur in its protein structure. Some individuals have a deficiency in the enzymes needed to oxidize sulfur. Such people may have problems with excess hydrogen sulfide production, which results in the individual excreting H_2S in breath, sweat and intestinal gas.

Bibliography

Health Assessment Document for Hydrogen Sulfide. U.S. EPA. EPA/600/8-86/026F. January 1993.

The Toxicological Profile for Hydrogen Sulfide, Agency for Toxic Substances and Disease Registry, U.S. Department of Health And Human Services 1998.

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